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Tactile Reading of Political Maps by Blind Students: A Videomatic Behavioral Analysis

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Running head: Map reading by blind students

Abstract

The problems in map reading by blind students were investigated with thirty-six blind students in grades 4-12 who were given the task of locating each of six shapes (U.S. states) on a tactile pseudo-political map. Maps of two levels of complexity were used and each subject's performance was videotaped. Accuracy (number of shapes located) and latency in locating the shapes showed no significant differences between map complexity or grade groupings. The videoanalysis indicated a number of map reading behaviors, primarily line tracing and shape recognition skills, that differentiated good readers from poor readers. Specific skills and concepts are suggested for remediation.

Tactile Political Map Reading by Blind Students: A Videomatic Behavioral Analysis

Reading tactile maps is an enormously difficult task for blind students. To a large extent, teachers have considered tactile maps to be of poor quality and difficult to read; therefore, have used them infrequently. The avoidance of maps by both teachers and students has resulted in a situation where blind students are severely deficient in geographical concepts (Franks & Nolan, 1970; 1971) and map reading skills (Berla', 1973 & Murr, 1974; Nolan & Morris, 1971; Wiedel & Groves, 1969). For example, Wiedel and Groves (1969) have reported that in a sample of 367 visually impaired students (ages 10-21 years), 72% reported receiving little or no training in map reading. These deficiencies exist in spite of the fact that of the embossed graphic displays included in one series of braille textbooks, maps represented the largest category (937 maps or 89.9% of the embossed displays) and of the 937 maps, 837 were raised line representations (Arampatta, 1970).

In order to acquire information from a raised line map, such as a political map, the fundamental task for the student is to differentiate a specified shape from among a mass of intersecting lines. The blind student is required to do this by exploring the tactile display with his fingertips in a serial-piecemeal inspection. This task is analagous to a difficult embedded figures test. Locating and differentiating a shape (county, state, country, etc.) from other shapes is a fundamental and necessary perceptual skill that needs to be developed before political maps can be used in the classroom.

The research questions asked were: Given a raised line map format, can blind students at their current level of skills locate and trace a shape

(state) on a map? What behaviors differentiate those who can (good readers) read a map from those who can't (poor readers)? It was felt that a study of this nature would serve as a heuristic device both for further research and to call attention to those skills and/or concepts in which poor map readers are deficient.

In the present study braille students were presented with a raised line map, given a series of cue cards (one at a time) that showed different shapes, and asked to locate and trace the same shapes on the map. During the course of performing the task, each student's performance was taped using a video camera.

Method

Subjects

The subjects were 36 students of both sexes enrolled at the Ohio State School for the Blind. All students used braille as their primary reading medium. Four students from each of grades 4-12 were randomly selected and participated as subjects. The means and standard deviations of the ages according to grade grouping and sex are presented in Table 1.

Insert Table 1 about here

Materials

Two pseudomaps were constructed and are shown in Figures 1 and 2. The maps were drawn in the following way: Six states of the United States were chosen on the basis of approximately equivalent sizes. The states with their areas in square miles were:

State	Area in Square Miles (km)
Alabama	51,078 (82,199.83)
Arkansas	52,725 (84,850.34)
Florida	54,262 (87,323.84)
Illinois	55,947 (90,035.51
Iowa	55,986 (90,098.27)
Wisconsin	54,715 (87,183.83)

Insert Figures 1 and 2 about here

The six states' boundaries were drawn from a base map in Readers' Digest Great World Atlas (1963, p. 47). The map scale was 1 inch (2.54 cm) to 142 miles (228.52 km) or 1 = 9,000,000. A braille page was divided into a grid having five rows and four columns. One of the six states was randomly chosen and this state was randomly assigned to one of the 20 cells on the page. Each state was placed in one of the cells with the restriction that no two states could occupy adjacent cells in the same column or row. Two identical drawings of the pseudobase map were made and additional boundary lines were added to each map to increase their complexity. Map A was constructed by adding 10 lines to the base map. Map B was constructed by adding five more lines to Map A. Consequently, Map A had 10 additional boundary lines and Map B had 15 additional boundary lines. The additional boundary lines were actual boundary lines of adjacent states taken from the U.S. base map and shortened where necessary to fit within the size of the paper.

Two tactile map molds were made from these line drawings using a photoetching process. The resulting male molds were used in a drape molding process to produce plastic copies. The height of the lines were .025 inch (.064 cm) and the width of the lines was .020 inch (.051 cm).

Each plastic map was mounted on cardboard with a nonskid backing. The size of the maps was 10 X 12 in. (25.40 X 30.48 cm.). Six cue cards were made, with each card showing one of the six bounded areas (states). The six shapes were made by cutting the shapes from one of the plastic copies of the pseudomap. Each shape was mounted on 5 X 5 in. (12.70 X 12.70 cm.) cardboard with a nonskid backing.

The practice-familiarization diagram consisted of four geometric figures (triangle, circle, square, and rectangle) placed in juxtaposition to one another and is shown in Figure 3. Plastic raised line drawings were made using the photoetching and drape molding process described previously. The practice diagram was 9 X 11 in. (22.86 X 27.94 cm.). Four cue cards were made each showing one of the geometric forms.

Insert Figure 3 about here

Design and Procedure

In order to familiarize the subject with the nature of the task, each subject was given the geometric diagram for practice before being shown the pseudomap. Each subject was given a cue card which showed a geometric form and asked to locate the shape on the larger display and to trace it with his finger. All four shapes were given to each subject in this manner. Following the practice task, the subject was presented with a test map (either A or B) and given 2 minutes of free exploration of the map. Following the inspection period, the subjects were presented with each state and asked to locate the state on the larger display. Each subject was required to inspect the cue card showing the state for a minimum of 30 seconds and a maximum of 1 minute. Each subject had up to 5 minutes to locate and trace the target state with his fingertips. Throughout the test period, the subjects were not given any instruction or corrections. If the subject was unable to locate the target state within 5 minutes, the

experimenter continued to the next shape. Each subject was given a different order of the six states. Each subject's performance was videotaped using a Sony sound videotape recorder.

Videoanalysis

The videoanalysis consisted of a qualitative analysis in which a particular subject was classified as either engaging in a behavior or not engaging in a behavior.

In order to obtain a list of descriptors for classifying the behaviors of the subjects on the map reading task, each of the 36 tapes was viewed by the senior author and a list of descriptors was compiled. There were three separate lists of descriptors, one for each component of the map reading task: preliminary scan of the map, inspection of the cue card, and the map search. On the basis of the accuracy and time scores, videotapes of the nine best and nine poorest map readers were chosen for further analysis. The nine best map readers were those subjects who located all the shapes with the lowest time scores and the nine poorest readers were those subjects who located the fewest shapes with the highest time scores.

The choice of the nine best and nine poorest map readers resulted in five males and four females in each group. The mean number of shapes located, the mean time in seconds to locate each shape, the mean age, and the mean grade level for each of the groups is presented in Table 2. The mean number of shapes located and the mean time in seconds to locate each shape for the whole sample is also shown in Table 2. In order to determine whether there were differences in age or grade level between the good and poor readers, separate t tests (two-tail) were computed. There were no significant differences between ages (t (16) = .05, p >.05) or grade levels (t (16) = 1.33, p >.05).

Insert Table 2 about here

In order to insure agreement on the precise definition of the various descriptors, two of the authors viewed four videotapes of students who were not included in the final set of 18, and categorized their behavior using the list of descriptors. Agreement was reached on each of the descriptors and the final set of 18 videotapes were viewed and analyzed in an alternating sequence of a good reader followed by a poor reader (G. P. G. P. . .).

Results

The three phases of the map reading task were analyzed separately:

Preliminary Scan

Since each subject in each of the two groups scanned the map once, the maximum possible score for each group was nine, (i.e., each of the nine subjects in each group could engage in a particular behavior or not engage in a behavior). Fischer's exact probability test was used to determine whether there were significant differences between the frequencies with which subjects in the two groups engaged in specific behaviors. Table 3 lists the various descriptors, the percentage of subjects who engaged in the behavior, and whether the differences in the frequencies were significant. As shown in Table 3, there were two behaviors which good readers engaged in more frequently than poor readers. A subject's scan was labeled complete if all six of the target states were touched during the course of the 2-minute scan. All of the good readers searched the map completely while only 44% of the poor readers searched the map completely. Second, although both good and poor readers traced at least one line during the preliminary scan, good readers traced lines significantly

more often than poor readers (100% vs. 56%). Characteristically, good readers appear to set themselves the task of inspecting and following lines, while poor readers not only inspect lines, but also inspect the area between the lines. There were no other significant differences between good and poor readers on the preliminary scan of the map.

Insert Table 3 about here

Except for the differences between good and poor readers noted, the preliminary scan of both good and poor readers can be characterized as a two-handed, rapid, global, and unsystematic inspection with the fingertips. As has been reported elsewhere, (Nolan & Morris, 1971) very few of the students determined the extent of the display they were searching before beginning their inspection.

For the most part, both good and poor readers appeared to perceive the map as a series of interconnected lines rather than a composite of juxtaposed shapes. The students followed the lines haphazardly without differentiating the shape, size, or distinctive features of a shape from other adjacent shapes. Consequently, it appeared as if very little useful information about the nature of the shapes was extracted by the students during the preliminary scan.

Inspection of Cue Card

Since each of the nine subjects inspected six separate cue cards in each of the two groups, there was a total of 54 opportunities for a specific behavior to be engaged in by each group of readers. The percentage of instances a particular behavior was engaged in was tabulated and differences in the percentages between good and poor readers was tested using a test of significance for the differences between proportions. Table 4 lists

the descriptors, the percentage of instances good and poor readers engaged in a behavior, and the $\underline{z}$ scores for the differences in percentages between good and poor readers. Table 4 shows a number of significant differences between good and poor readers in the frequency with which they engaged in different behaviors. Good readers (100%) completely traced the shapes significantly more often than poor readers (61%). The good readers characteristically picked out a point of origin and traced around the shape in a continuous motion and returned to the point of origin. Poor readers engage in this behavior less frequently. Their tracings were typically incomplete because of their failure to return to the point of origin or they haphazardly skipped around the shape feeling different parts without tracing the shape in one continuous motion. In addition, their inspections of the shape were significantly less detailed than good readers (57% vs. 96%). Poor readers did not follow the contour of the shape as closely as good readers. For example, a common response by some poor readers was to rapidly move their finger in a circular motion around the shape skipping distinctive features and corners and failing to follow the contour faithfully. Both the lack of a complete tracing and a detailed tracing were very striking differences between good and poor readers.

Insert Table 4 about here

Good readers also picked out distinctive features significantly more often than poor readers (74% vs. 56%). The operational definition used for determining this behavior was perserveration and inspection of a part of a shape to a greater extent than other parts of a shape. Except for the fact that good readers engaged in this behavior more frequently, there did not appear to be any differences in the location or consistency with which certain features were chosen by good or poor readers.

Poor readers also engaged in a number of other behaviors in inspecting the shape which good readers did infrequently or not at all. Poor readers inspected the shape with the flat of the hand significantly more often than good readers (17% vs. 2%), and felt the area on the inside of the shape significantly more often than good readers (9% vs. 0%).

One striking observation was the fact that both good and poor readers primarily used the index finger(s) to trace the shape, but good readers used the index fingers significantly more often than poor readers (93% vs. 67%), and poor readers tend to use their index, middle, and ring fingers collectively to trace the shape more often than good readers (22% vs. 0%).

Both good and poor readers used two hands (69% and 70%) more frequently than either hand alone (31% and 30%). However, the left hand was dominant significantly more often for poor readers (18%) as compared to good readers (0%). The right hand was dominant significantly more often for good readers (24%) as compared to poor readers (3%). Poor readers also used their left hand alone significantly more often than good readers (9% vs. 0%).

Map Search

Each subject was asked to locate each of six shapes separately. Consequently, there was a total of 54 opportunities for a specific behavior to be engaged in by each group of readers. Table 5 lists the descriptors, the percentage of instances good and poor engaged in a behavior, and the $\underline{z}$ scores for the differences in percentages between good and poor map readers.

The map search consisted of locating the target shape and tracing its contour. Both good (100%) and poor (94%) readers searched the map with their fingertips. However, good readers (77%) searched the map significantly

more often with the index finger than poor readers (59%), while poor readers depended more heavily on the first three fingers (index, middle, and ring) to a significantly greater extent than good readers (28% vs. 9%). Poor readers searched with the flat of the hand (15%) while none of the good readers engaged in this behavior and poor readers persisted significantly more often on one part of the map than good readers (15% vs. 2%). In addition, a small but significant proportion of the time, poor readers (9%) failed to search the map completely and their hands never touched the target shape at all, while all of the good readers made contact with the target.

Insert Table 5 about here

The two most striking differences between good and poor readers in the whole study occurred during the map search. First, poor readers had an enormously difficult time tracing lines. Poor readers were observed to have difficulty tracing lines 48% of the time, while only 4% of the good readers had difficulty. Specifically, poor readers were observed to fall off a line they were tracing significantly more often than good readers (35% vs. 0%). Poor readers also followed intersecting lines, while attempting to trace a shape, significantly more often than good readers (35% vs. 4%).

Second, good readers located the target shape 83% of the time by picking out one or more distinctive features of the shape on the map, while poor readers were observed to engage in this behavior 35% of the time. Good readers also checked the cue card significantly more often than poor readers (87% vs. 63%) as a means of determining if they had found the shape.

Lastly, once the target shape was located, good readers traced the target with their index finger more frequently than poor readers (100% vs. 92%).

The search strategy of the good readers can best be characterized as mainly a search for a critical distinctive feature rather than a search

for a whole shape. The good readers appeared to search the map looking for a distinctive feature with occasional checking of the cue card to determine if they had located the target feature. Once a critical distinctive feature had been located, this would serve as a signal to trace the contour of the shape to determine whether it matched either the cue card or their memory of the shape. It is difficult to characterize the strategies of the poor readers because they frequently engaged in a variety of irrelevant behaviors and did not engage in many relevant behaviors. However, it appeared that in some instances, the poor readers appeared to be looking for a whole shape based on its overall size and/or its general configuration. Other poor readers appeared to search for a critical distinctive feature but had difficulty differentiating it from similar distinctive features of other shapes on the map. Sometimes a poor reader would locate the critical distinctive feature, but would not know which way to trace the line. It appeared in these instances that the poor reader had little notion of the relationship or position the critical feature had in relation to the rest of the shape. Finally, in some instances, poor readers would fall off the line they were tracing and/or follow an intersecting line and lose their place and/or decide to go to a different part of the map.

Distinctive Features of Shapes

During each phase of the map reading task the distinctive features of each shape chosen by the subjects were circled on line drawings of each of the target shapes. Inspection of these figures indicated that during the preliminary scan very few of the subjects picked out distinctive features of the target shapes.

For the other two phases of the task, good readers picked out more distinctive features than poor readers, but there was little difference in the nature or location of the distinctive features chosen by good and poor

readers. The nature of the distinctive features chosen, apparently depended on the variation in the contour of the shape itself, rather than the skills of the reader. Shapes which had a greater variation in contour showed less consistency in the location and nature of the distinctive feature chosen, (e.g., Florida). The less the variation in the contour of the shape or the more prominent a distinctive feature was, the greater the consistency in the distinctive feature chosen by the subjects (e.g., Alabama). Examples of the distinctive features chosen by good readers for Florida and Alabama during the map search are shown in Figure 4. The lines around the shapes show the features chosen and the number inside the line indicate the number of subjects who chose that particular feature. Furthermore, the overwhelming majority of good and poor readers chose one or two distinctive features during the inspection or search phases. Very few subjects chose more than two features.

Insert Figure 4 about here

Map Design and Complexity

At the completion of the map reading task, the subjects were asked four questions, namely:

1. Why was the map hard to read?
2. What do you think was wrong with the map?
3. How could we make it better?
4. When I snowed you a shape, what did you look for on the map?

Of the 36 subjects, 22 (61%) responded with a specific answer to one or more of the first three questions. Of the 22 who responded, 20 (91%) indicated that the shapes on the map were too close together and/or needed to be separated.

In order to determine whether there were differences in the accuracy or the time to locate the shapes on Map A and Map B, separate analyses of variance were performed for each measure. The first analysis, using an arcsin transformation of the percentage of correct responses, consisted

of a two-way analysis of variance for independent groups with Maps (A vs. B) and Grade Groupings (4-6, 7-9, 10-12) constituting the two variables. There were no significant differences between any of the variables or the interaction. A summary of the analysis is shown in Table 6.

A second analysis was performed on the location time data with the time necessary to locate each shape as the dependent measure. A three-way analysis of variance was performed using a reciprocal transformation of the data. Grade Groupings (4-6, 7-9, 10-12) and Maps (A vs. B) constituted the between subjects variables and Shapes (1-6) constituted the within subjects variable. The analysis showed no significant differences between any of the variables or their interactions. A summary of the analysis is shown in Table 7.

Insert Tables 6 and 7 about here

Discussion

Locating a shape on a map, differentiating it from adjacent shapes, and tracing its contour are fundamental prerequisites for reading any raised line tactile map. Yet, a substantial proportion of the sample of students tested lacked the necessary skills to perform the task quickly and accurately. By comparing good map readers with poor map readers, it was possible to delineate a number of skills and concepts that need to be emphasized in the teaching of map reading skills.

Line tracing was the largest and most obvious problem the students encountered in working with the map. Their inability to trace a line was a persistent problem that was not confined to the lower grades, but permeated all the grades tested (4-12). The teaching and remediation in this skill is absolutely essential if raised line displays are to be used in any educationally meaningful way, whether they be maps, graphs, or diagrams. It should be noted that the authors have observed the line tracing problem informally

while conducting other research. In fact, in one study it was necessary to train students in line tracing before it was possible to begin the investigation (Berla' & Murr, in press). One technique found effective was to have the subject use the index finger of both hands, with one finger following the line while the other finger trailed behind. Then, when a line curved, or was broken, or interrupted by another symbol, or if the lead finger fell off the line, the trailing finger would hold its place while the lead finger located the continuation of the line. Training in line tracing should begin with straight lines, then extend to multicurved lines and crisscrossing lines. Proficiency in this skill would not only aid map reading, but also be useful in reading graphs and diagrams in mathematics and science texts.

Shape concepts and methods for inspecting shapes represented another major area of difficulty for the students. Although the students were able to discriminate and recognize simple geometric forms (triangle, circle, square, and rectangle), they frequently did not have general perceptual-conceptual skills to discriminate or recognize shapes that differ from the simple geometric forms they know so well. Good map readers located and discriminated the shapes by locating and comparing the distinctive features of the shapes. Teachers need to emphasize the concept of distinctive features ("parts that stick out or go in") and to teach students to compare shapes and recognize shapes by comparing and recognizing distinctive features. A shape can be conceived as an array of distinctive features. Consequently, the contour of a shape should be traced in a systematic way in order to convey information about the sequential order and relative positions of the distinctive features to each other. Students could be taught to trace the contour of a shape in a clockwise or counterclockwise direction as an initial introduction to the concept. In addition, the students should be taught to trace a shape in one continuous motion and return to the point of origin or what

Piaget calls decentration (Piaget & Inhelder, 1967). This would enable the student to gain some conception of the spatial relationships of the distinctive features and would also insure a complete tracing of the shape.

The videoanalysis also indicated that some students inspect the area between the edges or lines of a shape rather than the edge or contour line of the shape. While this may communicate information about size, it provides little information about the identity of a shape. Teachers need to emphasize that the most informative aspect of a shape is its contour or edge.

One can readily appreciate the difficulty students had in locating a shape on a map when they lacked both the ability to trace and the concept of a distinctive feature of a shape.

It was apparent that the best readers primarily used the fingertips of the index fingers to locate distinctive features on the map and to trace the shapes. Research in braille (Foulke, 1964; Lappin & Foulke, 1973) and letter recognition (Hill, 1973, pp. 95-105) indicates that performance is best when only the index finger is used. Using other fingers alone or in addition to the index finger either resulted in no improvement or decreased performance. Teachers need to emphasize the use of the fingertips of both index fingers for reading embossed displays. Students should be observed carefully to detect irrelevant or uninformative behaviors, such as the use of fingernails, scratching, passive placement of the hand, and searching a map with the flat of the hand.

In working with maps or any large embossed display, students should begin by defining the extent of the display and systematically search the display. These behaviors should enable the student to acquire general information about the display before beginning a detailed inspection or a specific task. As has been reported elsewhere (Berla', 1972; Nolan & Morris, 1971), few students spontaneously engaged in these behaviors. However, a few minutes of

training students to search a display with a two-handed vertical scanning technique has been shown to be an effective method for searching a display (Berla', 1972; Berla' & Murr, 1974).

Once students have acquired the skills and concepts described above, training should be begun to teach a child to recognize and trace a shape which is juxtaposed to other shapes. A tactile political map can be perceived either as a series of intersecting lines or as a collection of juxtaposed shapes sharing common borders. The ability to recognize a shape from a mass of intersecting lines, sometimes called disembedding, is an absolutely essential skill for reading raised line maps. Perceptual training in this skill could be begun by having students locate and trace common geometric forms which have been placed next to each other, as is shown in Figure 1. Training could then proceed to similar formats using unfamiliar geometric forms and simple political maps. In teaching the skill, the teacher needs to emphasize a systematic search for the distinctive features of the shapes.

In addition to improving the skills of the map reader, maps could also be redesigned to ameliorate some of the more obvious problems; like line tracing and the inability to perceptually separate juxtaposed shapes. For example, instead of using a very narrow line on maps, a relatively broad raised line could be used. The student could then trace the inside edge of the contour line of a shape. This might reduce his probability of following an intersecting line and aid his understanding that a map is a collection of juxtaposed shapes rather than a series of intersecting lines. Another alternative might be to have solid raised shapes that are separated by a broad incised line. One could liken this design to a dissectable map in which each of the raised shapes is spaced about .25 in. (.64 cm.) from all the neighboring shapes. It is not suggested that all maps be redesigned in this fashion,

but these types of map designs might be effective teaching aids when a student is first introduced to political maps. Once the student has learned the elementary skills and concepts, he may be able to use the typical raised line display more effectively.

Delay in training these skills or introducing these concepts until a student is forced by the nature of the subject matter to use embossed displays may be the reason teachers report having so much difficulty in using maps in social studies. Lack of training in the early grades allows the student to develop inappropriate skills, irrelevant habits, and distorted concepts about maps. It then becomes even more difficult to use embossed displays in the classroom.

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Footnotes

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Table 1

Means and Standard Deviations of Ages of

Subjects According to Grade Grouping and Sex

Group	Male	Female	Total
Grade	M = 13.01	M = 12.00	M = 12.67
levels	SD = .93	SD = 1.07	SD = 1.06
4-5-6	n = 8	n = 4	n = 12
Grade	M = 14.75	M = 14.64	M = 14.69
levels	SD = 1.12	SD = 1.92	SD = 1.57
7-8-9	n = 5	n = 7	n = 12
Grade	M = 18.37	M = 18.96	M = 18.56
levels	SD = 1.71	SD = 1.39	SD = 1.57
10-11-12	n = 8	n = 4	n = 12
	M = 15.47	M = 15.09	M = 15.31
Total	SD = 2.73	SD = 3.06	SD = 2.84
	n = 21	n = 15	N = 36

Table 2

Mean Performance Scores, Mean Ages, and Mean Grade Level for Good Map Readers, Poor Map Readers, and Total Sample

Behavior	Good readers	Poor readers	Total sample
Mean number of shapes located	6.00 (SD = 0.00)	2.89 (SD = 1.27)	5.06 (SD = 1.45)
Mean time per shape (in seconds)	58.15 (SD = 14.13)	210.74 (SD = 40.46)	117.92 (SD = 68.18)
Mean age (in years)	15.69 (SD = 3.00)	15.61 (SD = 3.53)	15.31 (SD = 2.84)
Mean grade level	9.22 (SD = 2.44)	7.44 (SD = 3.17)	8.00 (SD = 2.62)

Table 3

Frequency of Occurrence of Different Map Reading Behaviors

by Good and Poor Map Readers during Preliminary Scan

Behavior	Good readers	Poor readers
Systematic	0%	11%
Unsystematic	100%	89%
Complete [a]	100%	44%
Incomplete [a]	0%	56%
Traces lines [c]	100%	67%
Traces lines frequently [b]	100%	56%
Traces target areas	78%	44%
Traces non-target areas	33%	11%
Defines extent of display	22%	0%
Searches map with one hand	11%	11%
Searches map with two hands	100%	89%
Uses fingertips	100%	89%
Uses flat of hands	0%	11%
Uses fingernails	0%	11%
Notes distinctive features	44%	44%

a. $p = .015$

b. $p = .041$

c. $p = .10$

Table 4

Frequency of Occurrence of Different Map Reading Behaviors by Good and Poor Map Readers during Inspection of Cue Card

Behavior	Good readers	Poor readers	$\underline{Z}$ score
Detailed tracing	96%	57%	4.80**
Complete tracing	100%	61%	5.12**
Picks out distinctive features	74%	56%	2.01*
Traces key with:			
Left hand	0%	9%	2.29*
Right hand	31%	20%	1.32
Both hands	69%	70%	.21
Right dom.	24%	3%	2.67**
Left dom.	0%	18%	2.76**
Neither dom.	76%	79%	.31
Traces shape with two fingers on same hand	9%	2%	1.68
Feels shape between thumb and other fingers	20%	9%	1.63
Feels shape with flat of hand	2%	17%	2.66**
Feels empty space inside of key	0%	9%	2.29*
Fingers used in tracing key:			
Index alone	93%	67%	3.34**
Index and middle	7%	11%	.33
Index and middle and ring	0%	22%	3.67**

* $\underline{p} < .05$

** $\underline{p} < .01$

Table 5

Frequency of Occurrence of Different Map Reading Behaviors by Good and Poor Map Readers during Map Search

Behavior	Good readers	Poor readers	$\underline{Z}$ score
Uses fingertips	100%	94%	1.76
Use one hand:	37%	24%	1.46
Left hand	77%	80%	.21
Right hand	23%	20%	.21
Both hands:	76%	63%	1.46
Left dominant	0%	9%	1.94
Right dominant	5%	3%	.43
Neither dominant	95%	88%	1.09
Primary fingers used:			
Index alone	77%	59%	2.01*
Index and middle	13%	13%	----
Index and middle and ring	9%	28%	2.48*
Searches with flat of hand	0%	15%	2.94**
Searches with one hand on key	31%	22%	1.09
Finds distinctive feature on target	83%	35%	5.09**
Same distinctive feature as found on preliminary scan	21%	5%	.95
Same distinctive feature as inspection of key	84%	84%	----
Checks key after locating distinctive feature of shape on map	87%	63%	2.89**

Table 5 (continued)

Behavior	Good readers	Poor readers	$\underline{Z}$ score
After locating target, finds it on target, then on key	76%	53%	1.81
Traces target and key simultaneously	56%	34%	1.43
Hand never touches target	0%	9%	2.29*
Difficulty in tracing	4%	48%	5.27**
Falls off line while tracing	0%	35%	4.80**
Follows intersecting line while trying to trace target on map	4%	35%	4.13**
Finds target but can't trace it	0%	6%	1.76
Persists on one part of map	2%	15%	2.44*
Finds target and completes task	100%	48%	6.15**
Traces target with both hands	48%	46%	.16
Traces target with one hand:	52%	54%	.17
Traces target with left	71%	59%	.81
Traces target with right	41%	29%	.76
Traces target with index finger only	100%	92%	2.06*
Traces target with index and middle fingers	0%	4%	1.45
Traces target with index and middle and ring fingers	0%	4%	1.45

* $\underline{p} < .05$

** $\underline{p} < .01$

Table 6

Analysis of Variance on Percentage of States Located as a Function of Grade Groupings and Map Complexity Using an Arcsin Conversion

Source	SS	df	MS	F
Total	11.072143	35		
Between subjects	11.072143	35		
Grade	.441791	2	.220895	.63
Map complexity	.012837	1	.012837	.04
Grade x map	.021382	2	.010691	.03
Error	10.596133	30	.353204	

Table 7

Analysis of Variance on Mean Task Time to Locate a State as a Function of Grade Groupings, Map Complexity, and Order of Presenting States Using a Reciprocal Transformation

Source	SS	df	MS	F
Total	.142225	215		
Between subjects	.044427	35		
Grade	.004831	2	.002416	2.08
Map complexity	.004010	1	.004010	3.45
Grade x map	.000682	2	.000341	.29
Error	.034904	30	.001163	
Within subjects	.097798	180		
Order	.002919	5	.000584	1.13
Grade x order	.007989	10	.000799	1.54
Map x order	.001734	5	.000347	.67
Grade x map x order	.007368	10	.000737	1.42
Error	.077788	150	.000519	

Figure Captions

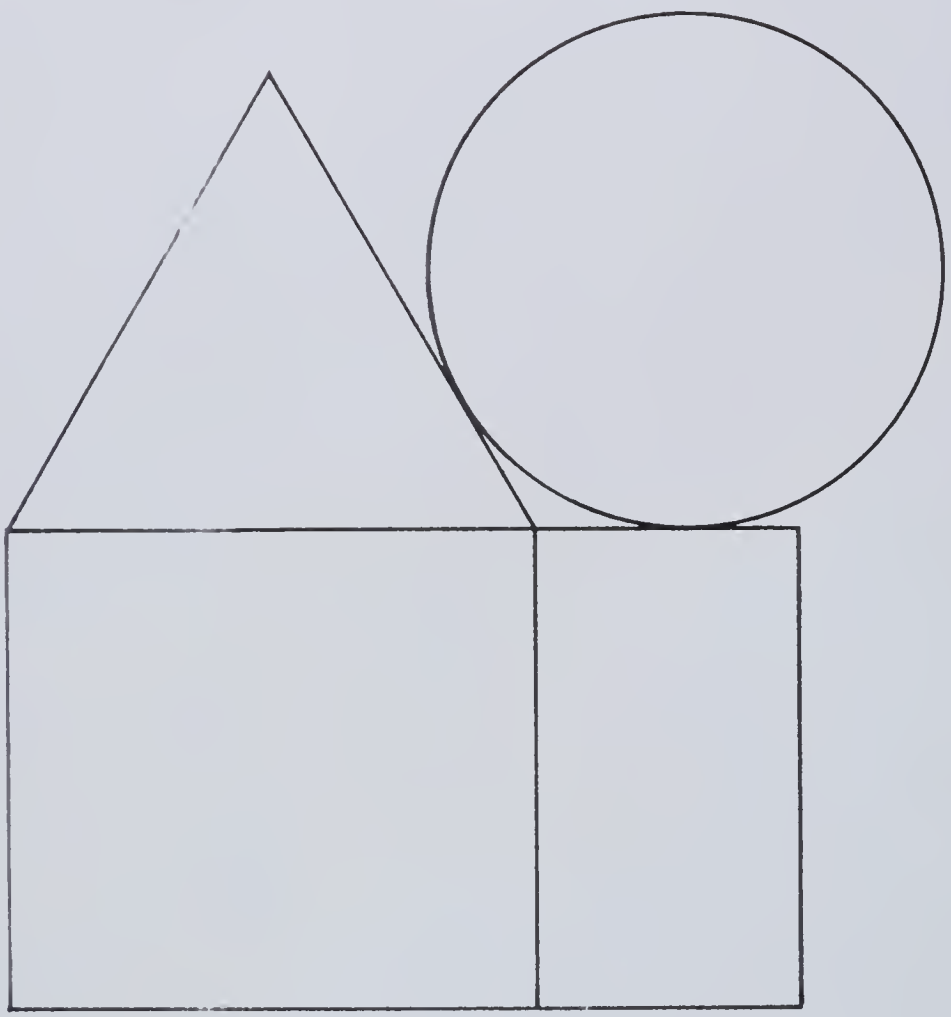
Figure 1. Tactile pseudomap A which had 10 additional boundary lines. The size of the map was 10 x 12 in. (25.40 x 30.48 cm.) with the height and width of the lines being .025 in. (.064 cm.) and .020 in. (.051 cm.) respectively.

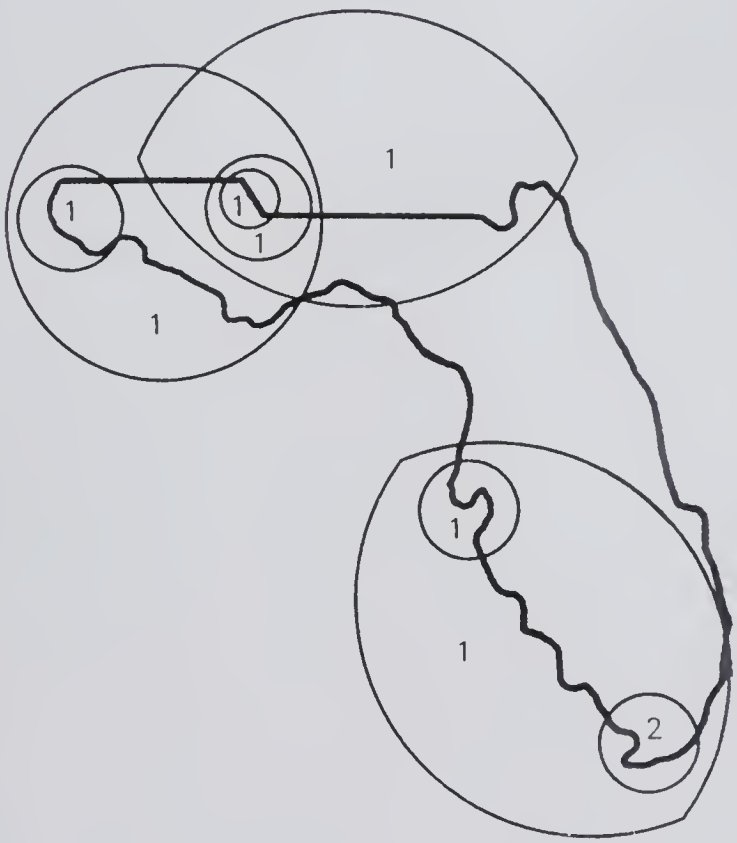
Figure 2. Tactile pseudomap B which had 15 additional boundary lines. The size of the map was 10 x 12 in. (25.40 x 30.48 cm.) with the height and width of the lines being .025 in. (.064 cm.) and .020 in. (.051 cm.) respectively.

Figure 3. The practice-familiarization diagram. The size of the diagram was 9 x 11 in. (22.86 x 27.94 cm.) with the height and width of the lines being .025 in. (.064 cm.) and .020 in. (.051 cm.) respectively.

Figure 4. Examples of the distinctive features chosen by good readers for Florida and Alabama during the map search. The lines around the shapes show the distinctive features chosen and the numbers inside the lines indicate the number of subjects who chose that particular feature.

IOWA
WISCONSIN
FLORIDA
ALABAMA
ILLINOIS
ARKANSAS




1
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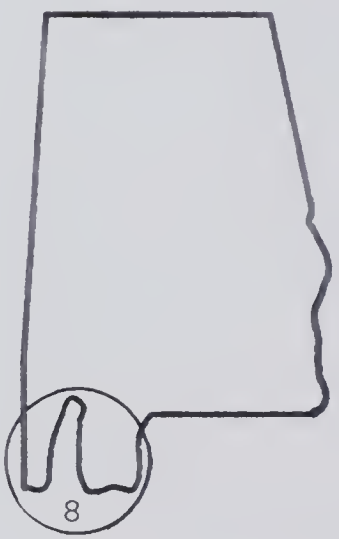
8

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APPENDIX B

This section consists of a list of some of the items which are available from the American Printing House for the Blind (APHB). Included are only the items which were conceived, developed, field tested, and made available to APHB for production and distribution largely through funds provided in Grants and Contracts since 1967. Procedures for the process of development are explained in detail in this report. Brochures for these items form the second part of this Appendix Section.

As is true in research and development in all areas, some items planned and developed, at least in part, were not put into final production for APHB distribution. This generally resulted from the item's not meeting IMRC and/or APHB criteria as stated: (1) filling a need (2) not available (3) for student use. Only one item completed and offered for distribution was withdrawn because of its not meeting standards set by O.E. As has been indicated, the policy of the IMRC Research and Development has been to develop, test, re-develop, re-test, and re-develop until an item seemed to be what was needed, of top quality, and available only through our distribution.

Abacus (Large) - An enlarged design which retains the special features of those for easier control by the blind and is especially helpful to: (a) the young blind who lack good manipulative skills (b) adult blind who have difficulty with manipulation and/or tactual discrimination.

APH Number Line Device - Developed for use by visually handicapped students working at the primary level to bridge a gap between the concrete and the abstract. This device can be used to present many of the concepts which are included in contemporary elementary school mathematics programs as well as to discover and reinforce mathematical concepts.

Biological Models - Developed as supplementary aids for teaching biology to blind students. The most important biological features are emphasized tactually on simplified models. Features are chromatically represented on a white background, where possible, to maximize color contrast for students with low levels of residual vision.

Bold-Line Writing Papers - Four types are now available: (1) for primary or beginning students of writing, (2) for grade school pupils, (3) for notebook use, and (4) for letter writing.

Braille Code Recognition (BCR) Materials and Instructional Kit - Based on research done by Henderson (1967) and Umsted (1970), this material provides systematic training to increase speed and accuracy of Braille contractions, word signs, and short form words.

Chang Mobility Kit (Modification) - This kit is a light, portable unit, consisting of geometric forms in different shapes and sizes, plus a baseboard. Designed first as a tactual aid for instructors of orientation and mobility, the various forms can be arranged to simulate basic representations of street layouts.

Dolch Word Cards, Large Type and Braille - Combines the Dolch Popper Words Set I and Set II. Words in these sets consist of the Dolch 220 Basic Sight Words and include the most commonly used pronouns, adjectives, adverbs, prepositions, conjunctions, and common verbs which must be recognized by sight before a child can read with interest and confidence. The cards may be used in conjunction with first and second grade readers or they may be used independently for drill and review.

English-Metric Rulers - Raised lines, braille figures, and caliper slides are added to these rulers which make measuring possible and aids in relating the different systems.

Formboard With Removable "Hands" - A pre-reading aid consisting of a wooden formboard with removable wooden "hands" designed to accompany the Braille reading-readiness book, Touch and Tell. This formboard consists of a wooden base painted gray, incised with a left and right hand into which are fitted two wooden blocks, painted blue, in the same shape and size of left and right hands. The top of the "hands" are smooth, but the bottoms are textured, so a child can tell which is top and which is bottom.

Fractional Parts of Wholes - Designed as a tactile analog to parallel educational materials available to sighted students, the kit consists of a wooden work tray, three plastic form boards containing empty nests. The uniqueness of the kit for the blind lies in the combination of the work tray, form board nests for the parts, and parts which rise above the form board nests.

Geometric Area and Volume Aid (GAVA) - With this set of geometric blocks, it is possible to construct models of three-dimensional figures relating to surface area and volume which are most often found in elementary mathematics texts.

Geometric Forms - Designed for primary level visually handicapped students, this aid introduces the shapes of the circle, the square, and the triangle.

Giant Textured Beads - This set of materials consists of 12 large wooden beads of three different shapes. Three surface textures are provided for each shape. The stringer consists of a white nylon cord with a wooden stop at one end and a pliable nylon tip at the stringing end.

The purpose of the beads and stringer is to introduce the kingergarten-early primary level child to: (a) solids of three

different common shapes, sizes, and textures, and (b) bead-stringing on a gross, easily manageable level, for the purpose of developing muscular coordination.

Individual Study Screen - The Individual Study Screen provides 7X magnification and close viewing for the low visioned child who cannot profit from group viewing of film strips and other materials when projected on a large screen and viewed at a distance.

Insect Identification Kit - Developed to teach the body parts of insects to young primary level visually handicapped students, to encourage students to examine and distinguish differences and likenesses in insects, and to reinforce identification of the insect which appears in illustrations with other small invertebrates in primary grade science books.

Landform Models - The Landform Models were developed as supplementary aids for teaching basic geographical concepts to visually handicapped students. The set illustrates 40 geographical concepts which are introduced in the elementary social studies curriculum. These concepts were found to be largely unknown at various grade levels.

Large Textured Block - Recommended for use by the kindergarten-early primary level child or the older child with multiple handicaps, it is designed with four colors and four textures for simple matching and comparisons. The frame incorporates a homing principle so that a very young child, or a child with multiple handicaps can fit the block into it with very little difficulty. Accompanying the frame and block are plane insets of each color and texture used in the block. The insects can be placed in the frame for duplication purposes.

Large Type Outline-Maps (Desk Size) - The Large Type Outline desk maps adapted from the Nystrom Series of Desk Maps, are printed in black ink on a regular buff antique-finish paper. Outlines of individual states are shown in light type with bolder type enclosing an approximate geographical region. Each map has an insert which depicts the location of a geographical region in relation to the rest of the continental United States, except on the map of the United States when the inserts display Alaska and Hawaii. Longitude and latitude (West of Greenwich) lines are also shown on the maps and are placed on the borders of each map but do not dissect the map. A linear scale is included on each map with scale indicated in miles.

"Listen and Think" - Educational Developmental Laboratories granted special permission to adapt these tapes for use with visually handicapped students. EDL designed the program for the purpose of improving listening comprehension and developing specific thinking skills that are necessary to good listening.

Materials on Utilization of Low Vision - The materials are presented in the belief that when a child's vision is impaired in the eye, he must be led carefully step-by-step in his visual development and taught how to use the vision he has and to understand what he is able to see.

Multiple-Choice, Multiple-Purpose Answer Sheets - In many testing situations, a multiple-choice, multiple-purpose answer sheet provides a simple method of responding to auditory or printed questions of whatever nature. To meet such a generalized need, parallel Braille and large type sheets are provided.

Peg Kit - Recommended for use by the preschool-early primary level child or the older child with multiple handicaps. Tasks with the peg kit may include manipulation, number or language concepts, and size, color, and tactual discrimination. The kit was so designed that no two features can be matched simultaneously.

Puzzle Form-Board Kit - Designed for use by the preschool or primary level child as a multi-purpose supplementary aid in learning basic concepts of form, shape, texture, color, size, and manipulation, only the parts which are relevant to a specific teaching situation should be used at any given time.

Science Measurements Kit - Provides equipment needed to illustrate and explain basic operations of measurement to blind students in elementary and junior high school science courses. The kit includes a number of items available commercially. All adaptations were kept as simple as possible, and all items were field-tested to prove their efficiency when used by blind students.

Seated Parquetry Set - Parquetry set for low-visioned children to provide formboards which control the work space and hold individual pieces seated even if elevated at an angle of considerable degrees. The stimulus cards and the accompanying seated formboards provide a vehicle which require students to actively use their vision, but allow better posture than might be maintained otherwise.

Sensory Cylinder Set - Composed of six fiber cylinders, weighted so as to produce three pairs of weights. The cylinder set has been so designed that no two matches of weight, texture or color can be made simultaneously.

Shape Board - The purpose of this device is to provide the primary-elementary level child with the opportunity to discriminate, sort, and classify different shapes on several bases, i.e., shape, size, like or different, color, and so on.

Shoelace Aid - The purpose of the Shoelace Aid is to teach shoelacing and tying to kindergarten and elementary grade children, as well as others who are in need of developing muscular coordination and manual dexterity.

A distinctive feature of the Shoelace Aid is that it provides for the teaching of lacing and bow-tying on a simplified basis, but in the normal shoe position.

Simple Machines Kits - The Simple Machines educational aids were developed by the Instructional Materials Reference Center of the American Printing House for the Blind in order to present concepts related to scientific principles involved in the use of machines.

There are three kits. Each kit contains working models of simple machines and an instruction manual which provides the required theoretical information and a variety of experiments. The experiments vary in degrees of difficulty. The kits may be ordered separately and should be used at fourth grade level and above.

Tactile Ruler Familiarization Unit - Developed to introduce measurement concepts and operations to young primary level blind students, this aid illustrates English, Metric, and English-Metric measurement units. This aid allows the teacher to introduce in simple fashion the operations involved in performing measurement tasks while introducing concepts.

Tactual Aids for Reading (TAR) - A set of aids for use in developing beginning reading skills consisting of a collection of 175 objects, identified through extensive textbook analysis and evaluation.

A Tactual Road to Reading - A reading readiness program for children who need Braille as their reading medium. The program is fully explained in a guidebook which accompanies it and specific techniques for using the materials are contained in the lesson plans.

Wooden Constructo Sets - The devices are similar in design and purpose to the metal erector sets which have been available commercially for many years, but the pieces are made of wood and are much larger in size to enable the blind child to handle the pieces effectively.

Work-Play Trays - Trays of two sizes, each designed to provide contained limits within which a child can work or play with toys and other materials. Either tray is small and light enough to carry it about as he pleases.